ARRAY ENVIRONMENTAL IMPACT ASSESSMENT

MARINE MAMMAL CONSULTATION NOTE 1

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GLOSSARY

Acronym	Description
Array	Offshore components of Ossian, including infrastructure such as wind turbines, offshore substation platforms and inter-array/interconnector cabling.
Array Marine Mammal Study Area	Study area defined by the site boundary plus 8 km buffer.
Availability bias	An estimator of the probability that an animal is available for detection (i.e. visible) at any randomly chosen time.
Bio-season	Division of the year according to species-specific traits that change throughout the year, for instance spatial distribution, or breeding cycle.
Coefficient of Variation	A measure of variability, calculated as the ratio of the standard deviation to the mean of a data set.
Mysticetes	Large whales from the taxonomic group Mysticeti that feed using a filtering mechanism comprised of baleen plates.
Management Unit	Management units (MUs) for marine mammals in United Kingdom (UK) waters that provide an indication of the spatial scales at which impacts of plans and projects alone, cumulatively and in combination, need to be assessed for the key cetacean species in UK waters, with consistency across the UK. For cetaceans, these MUs are defined by the Inter-Agency Marine Mammal Working Group (IAMMWG). For seal species (harbour and grey seal), seal MUs are defined by the Special Committee on Seals (SCOS).
Odontocetes	A marine mammal of the suborder Odontoceti, characterised by an asymmetrical skull, a single blowhole, and rows of teeth, feeding primarily on fish, squid, and crustaceans.
Phocid	Seals of the family Phocidae, represented in the UK by two species: grey seal *Halichoerus grypus* and harbour seal *Phoca vitulina*.
Pinniped	Marine mammals that have front and rear flippers, and live in the ocean but can come to land for long periods of time. This group includes seals, sea lions and walruses.
Site Boundary	The offshore area in which the Array will be constructed.
Telemetry	The use of animal-borne sensors to collect and record information on the animals or the environment. In the case of marine mammals this may include data on the location, movement, behaviour or physiological state of the individual, and information on water temperature, salinity, or light levels.

ACRONYMS

Acronym	Description
ADD	Acoustic Deterrent Devices
CV	Coefficient of Variation
DAS	Digital Aerial Surveys
EIA	Environmental Impact Assessment
EMF	Electromagnetic Field
GEBCO	General Bathymetric Chart of the Oceans
BGS	British Geological Survey
HRA	Habitat Regulations Appraisal
IAMMWG	Inter-Agency Marine Mammal Working Group
MD-LOT	Marine Directorate – Licensing Operations Team
MMO	Marine Mammal Observer
MU	Management Unit
NMFS	National Marine Fisheries Service
Ossian OWFL	Ossian Offshore Wind Farm Limited
PAM	Passive Acoustic Monitoring
PTS	Permanent Threshold Shift
RL	Received Noise Level
SAC	Special Area of Conservation
SCANS	Small Cetaceans in European Atlantic waters and the North Sea survey
SCOS	Special Committee on Seals
SEL	Sound Exposure Level
SEL_{cum}	Cumulative Sound Exposure Level
SEP	Stakeholder Engagement Plan
SMRU	Sea Mammal Research Unit
SNCBs	Statutory Nature Conservation Bodies
SNU	Seoul National University
SPL_{pk}	Peak Sound Pressure Level
SSS	Side Scan Sonar
TNO	Netherlands Organisation for Applied Scientific Research
TTS	Temporary Threshold Shift
TUHH	Hamburg University of Technology
UHRS	Ultra-high Resolution Seismic
UK	United Kingdom
UXO	Unexploded Ordnance
V	Velocity
WTD	Naval Weapons and Maritime Technology and Research

UNITS

Unit	Description
α	Attenuation Coefficient
%	Percentage
λ	Wavelength
dB	Decibel (measure of sound)
Hz	Hertz (frequency)
kg/m^3	Kilogram per cubic meter (density)
kHz	Kilo hertz (frequency)
km	Kilometres (distance)
km^2	Square kilometres (area)
m/s	Metres per second (velocity)

1. INTRODUCTION

1. This consultation note is submitted as a part of the Stakeholder Engagement Plan (SEP) for the Ossian Array (hereafter referred to as 'the Array') and provides an update to the consultation completed to date for the Array with regard to marine mammals:

   - pre-Scoping workshop, held on 11 November 2022, to provide further information to stakeholders ahead of the Array Environmental Impact Assessment (EIA) Scoping Report (hereafter referred to as 'Scoping Report') (Ossian OWFL, 2023a) and gain agreement with the approach to the marine mammal assessment for the Array;
   - Scoping Opinion received on 14 June 2023 with feedback from the Marine Directorate – Licensing Operations Team (MD-LOT) and Statutory Nature Conservation Bodies (SNCBs; NatureScot and Natural England) on the scope and level of detail of the information to be provided by Ossian OWFL (hereinafter referred to as 'The Applicant') in the Array EIA Report with regard to marine mammals (MD-LOT, 2023); and
   - Array marine mammal methodology note submitted to the SNCBs on 19 September 2023 (Ossian OWFL, 2023b) to reach agreement on the approach to the marine mammal assessment for the Array as well as the response to the Array marine mammal methodology note received from NatureScot on 27 September 2023.

2. The content of this consultation note is intended to be read alongside the Scoping Report (Ossian OWFL, 2023a) and the Array marine mammal methodology note (Ossian OWFL, 2023b) as it aims to clarify the queries which were raised by SNCBs in their responses. Additionally, following the recent release of Marine Scotland's review of energy conversion factors (Wood *et al.*, 2023), it was highlighted that the sound field from impact piling features a Mach cone wavefront for which the propagation from a line source, which can lead to different rates of energy loss if a point source model is used. As such, this consultation note provides an opportunity to share a more detailed account of the revised underwater noise methodology and it should be read alongside the Ossian Underwater Sound Modelling Methodology note (Ossian OWFL, 2023c).

3. Specifically, this consultation note:

   - summarises the updated underwater noise modelling methodology for piling and the use of a linear model (section 2);
   - summarises findings of the site-specific Digital Aerial Surveys (DAS; section 3.1) and telemetry study (section 3.2);
   - provides information on species taken forward to the assessment in the Array EIA Report alongside further justification for the preferred species-specific densities derived from publicly available sources or DAS data (section 3.3);
   - establishes the designated sites taken forward to the assessment in the EIA and Habitat Regulations Appraisal (HRA; section 4); and
   - lists the impacts to be scoped in and the approach to the marine mammal assessment associated with the underwater noise impact of the Array (section 5).

4. The Array will be constructed within the offshore site, hereinafter referred to as the 'site boundary'. Throughout this consultation note references will be made to the Array marine mammal study area which encompasses the site boundary plus an 8 km buffer (synonymous with the Digital Aerial Survey area), as well as the regional marine mammal study area which covers a larger range across the wider northern North Sea due to the highly mobile and wide-ranging nature of marine mammal species. The site boundary, Array marine mammal study area, and regional marine mammal study area are presented in Figure 1.1.

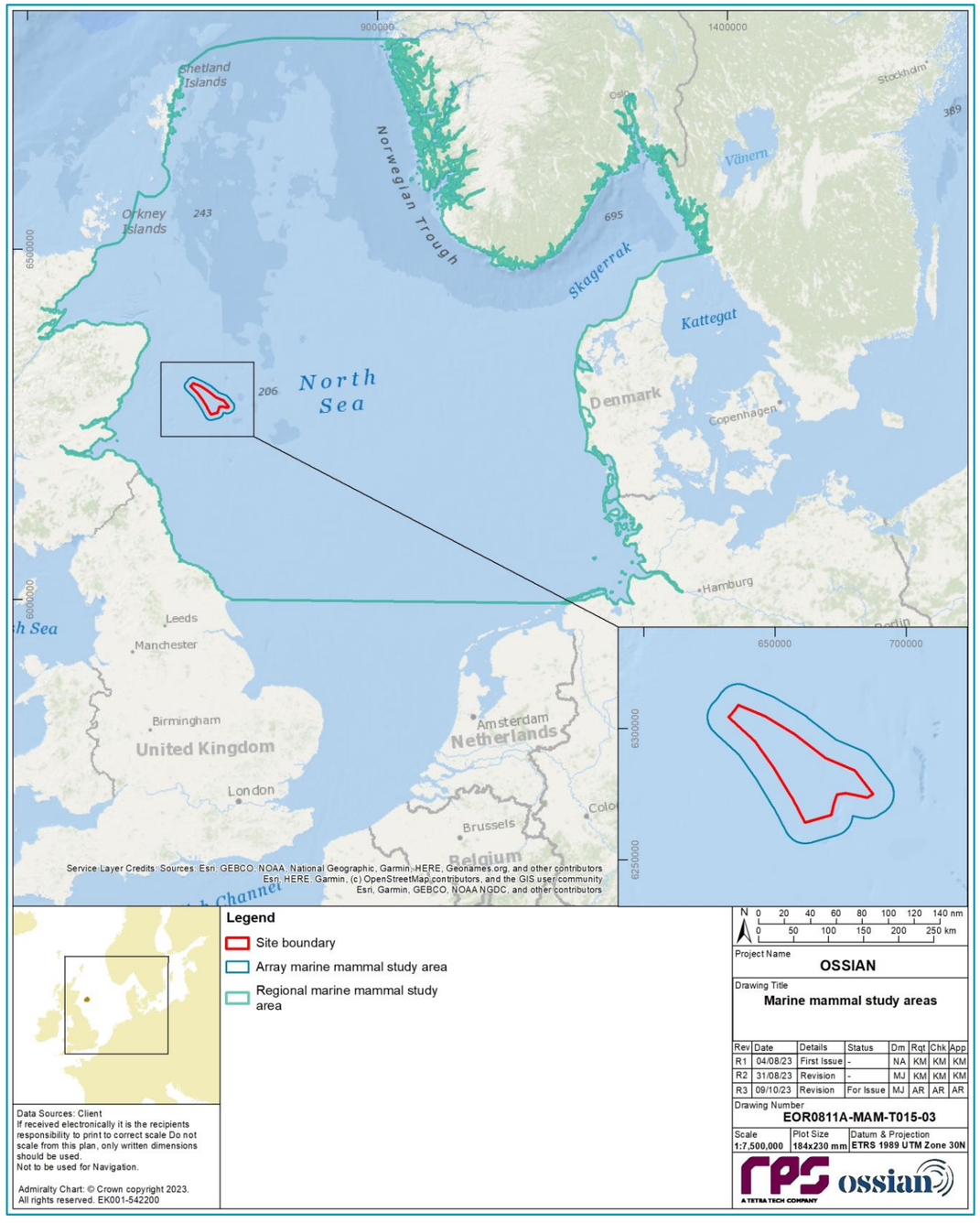

Figure 1.1: Array Site Boundary and Marine Mammal Study Areas

2. UPDATED UNDERWATER NOISE METHODOLOGY FOR PILING

2.1. OVERVIEW

5. With regards to the underwater noise modelling methodology, MD-LOT and SNCBs agreed with the approach presented in the Scoping Report (Ossian OWFL, 2023a). In the Scoping Opinion, both MD-LOT and NatureScot highlighted that a report on '*Energy Conversion Factors in Underwater Radiated Sound from Marine Piling*' should be considered as part of the Array EIA Report (MD-LOT, 2023). As project timelines for the Array EIA Report required the underwater noise modelling to be started and given that the publication date of this report was still unknown, the Ossian Underwater Sound Modelling Methodology note was shared with SNCBs on 19 September 2023 presenting the approach to underwater noise modelling to be completed for the Array based on the use of a point source model (Ossian OWFL, 2023c). Although the Applicant received an endorsement for this approach from NatureScot on 27 September 2023 (*email comms),* it has been subsequently reconsidered in light of the Wood *et al.* (2023) publication. Wood *et al.* (2023) discusses potential issues with representing a pile as a point source throughout, so the underwater noise specialist's (Seiche Ltd.) recommendation was to apply a line source model in the underwater noise modelling for the Array to ensure more realistic modelled underwater noise. The revised underwater noise methodology uses a line-array normal mode solver for low frequencies as well as a line-source energy flux model for high frequencies and it has been suggested for use in the email to NatureScot shared on 09 November 2023.

6. This section provides details of the proposed revised underwater noise modelling methodology for piling for the Array, replacing section 4 ('Sound propagation modelling methodology') of the previously issued Ossian Underwater Sound Modelling Methodology note dated 10 of August (Ossian OWFL, 2023c). Consequently, the following aspects of the methodology presented in the Ossian Underwater Sound Modelling Methodology note remain unchanged:

- injury and disturbance thresholds;
- pile source level determination; and
- sound exposure calculations.

2.2. PROPAGATION MODELLING METHODOLOGY

7. In the case of offshore pile installation using an impact hammer, the sound source can be thought of as a "line source" extending through the water column (or in the case of installations using a submersible hammers, a line source through a lower portion of the water column). The hammer strike at the top of the pile produces a compression wave in the pile resulting in radial displacement of the pile walls which is transmitted into the surround media (water and sediments) as sound waves. These compressional waves travel through the pile at circa 5,000 m/s, resulting in a conically shaped wavefront.

8. Underwater acoustic propagation modelling for this project will be undertaken using a combined distributed line-source array normal mode model for low frequencies (<1 kHz) complimented by a line-source energy flux model for high frequencies (>1 kHz).The line source normal mode model is based on the KrakenC solver (Porter, 2001) implemented for a line array over the pile length. The line-source energy flux model is based on an implementation of the energy flux model for a directional source set out in de Jong *et al.* (2019).

9. The normal-mode method involves solving a depth-dependent equation based on the assumption of a set of modes of vibration which are roughly akin to the modes of a vibrating string (Jensen, 1994).The complete acoustic field is constructed by summing up contributions of each of the modes weighted in accordance to the source depth. The KrakenC solver finds the normal modes in the complex wavenumber plane, which allows it to deal with elastic seabed layers, and to include the effects of leaky modes, making it a good choice for calculation of low frequencies for both close and long range sound fields. The method is, however, slow at higher frequencies and has therefore only been implemented for low-frequencies (<1 kHz).

10. The line-source energy flux model (de Jong *et al.*, 2019) used for higher frequencies includes the effect of directionality of the cone shaped wavefront associated with piling noise (circa. 17 degrees). This results in damped cylindrical spreading at shorter ranges and mode stripping behaviour at more distant ranges. At even more distant ranges, once the 'mode stripping' has eliminated the contribution of all waveguide modes except the lowest mode, propagation is evaluated according to a single mode regime.

11. For estimation of propagation loss of acoustic energy at different distances away from the sound source location (in different directions), the following steps were considered:

- The bathymetry information around this chosen source points will be extracted from the General Bathymetric Chart of the Oceans (GEBCO) database in 72 different transects.
- A geoacoustic model of the different seafloor layers in the survey region will be calculated based on the British Geological Survey (BGS) borehole database and Emodnet sediment database.
- A calibrated line-source propagation model will be employed to estimate the transmission loss matrices for different frequencies of interest (from 25 Hz to 80 kHz) along the 72 different transects.
- Source levels for the line-source array will be determined based on a back-calculation from the received sound level and spectrum shape at 750 m (based on the scaling laws set out in von Pein *et al.* (2022).
- The calculated source level values will be combined with the transmission loss results to achieve a frequency and range dependant Received Noise Level (RL) of acoustic energy around the chosen source position.
- The Temporary Threshold Shift (TTS) and Permanent Threshold Shift (PTS) potential impact distances for different marine mammal groups will be calculated using relevant metrics and weighting functions (from (Southall et al., 2019) and by employing a simplistic animal movement model (directly away from the sound source) where appropriate (for more detail on moving animal calculations in section 5 of the Ossian Underwater Sound Modelling Methodology note (Ossian OWFL, 2023c)). For assessing marine mammal disturbance using single pulse Sound Exposure Level (SEL), no frequency weighting is applied. For more details on injury and disturbance thresholds see section 2 of the Ossian Underwater Sound Modelling Methodology note (Ossian OWFL, 2023c).

2.3. MODEL CALIBRATION

12. The Seiche line array model has been benchmarked against the COMPILE benchmark workshop for numerical models for pile driving acoustics (Lippert *et al.*, 2016). The COMPILE workshop included modelling results from a number of different organisations in an attempt to compare the performance of acoustic models for piling against pre-defined input parameters. The models included in the benchmarking exercise included those developed by Seoul National University (SNU), Netherlands Organisation for Applied Scientific Research (TNO), Hamburg University of Technology (TUHH), Jasco Applied Sciences, Curtin University and Bundeswehr Technical Centre for Ships and Naval Weapons and Maritime Technology and Research (WTD).

13. A comparison between the Seiche model and the benchmark workshop model results is shown in Figure 2.1. The results of the benchmarking exercise show good correlation with the other models with the results most closely matching the TNO model. The Seiche model predicts slightly higher received levels compared to the other models at 20 km range for this particular benchmark scenario (10 m water depth, sand substrate). Nevertheless, it is considered that the results of the benchmarking exercise demonstrate a good degree of agreement with other sound propagation models for piling.

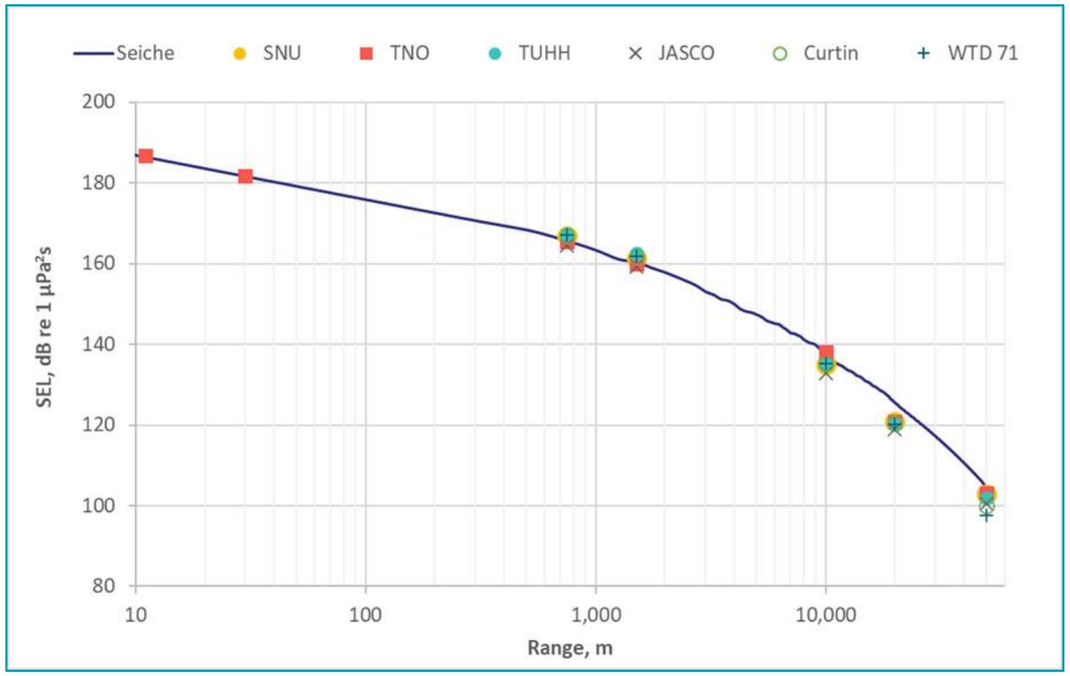

Figure 2.1: Comparison of Seiche Underwater Acoustic Model Against COMPILE Benchmarks

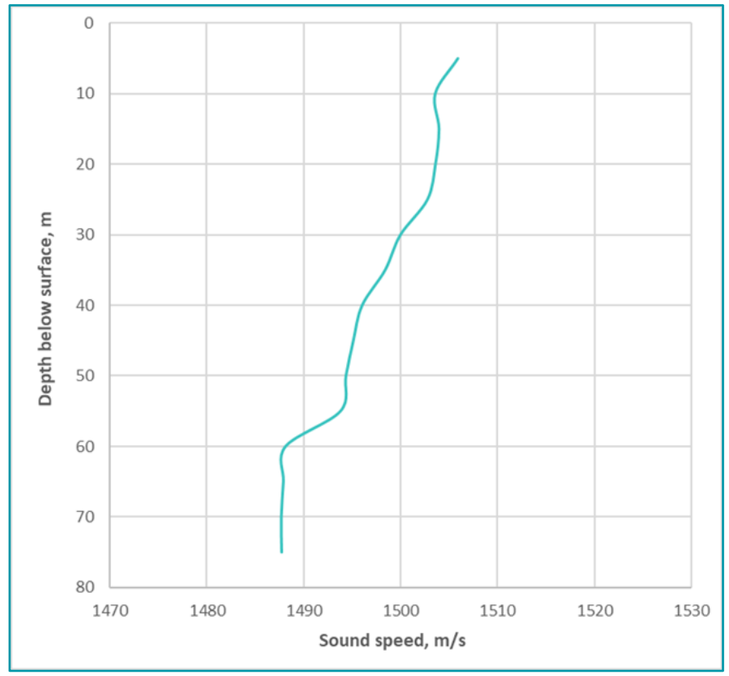

Figure 2.2: Sound Speed Profile Used in Propagation Model

2.4. GEO-ACOUSTIC AND SOUND-SPEED INPUT PARAMETERS

14. Based on BGS core data in the vicinity of the Array the geo-acoustic model is based on the parameters presented in Table 2.1. The sound speed profile has been based on the mean summer temperature and salinity profile for the region, as presented in Figure 2.2

Table 2.1: Geo-acoustic Model Used in Propagation Model

Start depth	End depth	Layer	V_p, m/s	V_s, m/s	α_p, dB/λ_p	α_s, dB/λ_s	density, kg/m^3
0	20	Sand	1,685	270	0.89	2.5	1,941
20	28	Clay	1,500	100	0.2	1	2,334
40	48	Clay	1,500	100	0.2	1	2,334
48	52	Sand	1,652	262	0.89	2.5	1,771
52	90	Clay	1,500	100	0.2	1	2,334
90	Halfspace	Siltstone	3,800	2150	0.1	0.25	2,400

3. BASELINE

3.1. DIGITAL AERIAL SURVEYS

15. The DAS of the Array marine mammal study area commenced in March 2021 and continued monthly up to and including February 2023 to allow 24 months of data collection. Detailed analysis of the data will be presented in the Array EIA Report Chapter, though this section will provide a short overview of the raw count data for each of the species or species groups as well as a summary of the density calculations.

16. In the Array marine mammal methodology note, shared with stakeholders on 19 September 2023 (see paragraph 1), the Applicant presented the methodology for the analysis of the DAS raw count data, including corrections for the availability bias and species distribution (density and abundance) modelling.

17. Estimating the true density of species that spend the majority of their time below the surface and undetectable by visual surveys (i.e. availability bias) is challenging to achieve accurately. Field observations often result in biased estimates of population parameters due to imperfect detection of the species of interest (Sucunza *et al*., 2018; Buckland, 2001) and this is an area of ongoing research focus. There is no specific guidance on the most appropriate method to apply for EIA, but, for harbour porpoise, a commonly used approach applies correction factors presented by Teilmann *et al*. (2013), which were obtained via satellite tracking of harbour porpoise between the Baltic and North Seas.

18. The estimates of absolute density described in the Array marine mammal methodology note are based upon the most conservative observation of time spent submerged between 0 and 2 m, as presented by Teilmann *et al*. (2013). Relative densities were calculated by adjusting raw counts for survey effort, and

absolute densities were then calculated by dividing relative densities by the proportion of time at 0 to 2 m, to correct for availability bias. The majority (66%) of harbour porpoise identified during DAS were observed below the water's surface, so the correction factor for submerged animals was applied throughout. The Applicant received positive feedback on the approach proposed in the Array marine mammal methodology note from NatureScot on 27 September 2023.

19. It should be noted that the HiDef Year 2 DAS Report (Issue 2, dated 18 August 2018) (HiDef, 2023), shared with stakeholders on 31 August 2023 included calculations of harbour porpoise *Phocoena phocoena* absolute densities made using correction factors and methodology that was not consulted upon for the Array with MD-LOT and SNCBs. Estimates of absolute density presented in the HiDef Year 2 DAS Report used site- and time-specific correction factors calculated from the results of modelling presented by Teilmann *et al*. (2013). However, the correction factors used are based upon animals above the surface, rather than animals at 0 to 2 m. Since harbour porpoise were observed by Teilmann *et al*. (2013) to spend less time surfacing (between 3.4% and 6.0% of the time) than at 0 to 2 m (between 42.5% and 61.5%) the resulting estimates of absolute density are substantially higher than if calculated using correction factors for submerged animals. The potential skew has been addressed by taking submerged animals into consideration when calculating correction factors, although estimates remain higher than if surfacing and submerged animals had been treated separately.

20. Considering the above justification and the methodology consulted for the Array with stakeholders, only the approach presented in the Array marine mammal methodology note has been applied to the DAS raw count data analysis summarised in section 3.1.2 to calculate the species-specific densities presented in section 3.3. Given the disparate approach used for calculations of absolute densities presented in the HiDef Year 2 DAS Report (HiDef, 2023), harbour porpoise absolute densities have subsequently been omitted and the final version of the HiDef Year 2 DAS Report will include only marine mammal raw counts (used in data analysis summarised in section 3.1.2) and relative densities.

3.1.1. SPECIES COUNTS

21. Harbour porpoise accounted for the highest number of sightings identified to species level (based on raw count data) during DAS and was recorded in all but three survey months (Table 3.1). white-beaked dolphin *Lagenorhynchus albirostris* accounted for the second highest number of sightings and was recorded in seven months over the 24-month survey period. For other sightings identified to species level – grey seal *Halichoerus grypus*, minke whale *Balaenoptera acutorostrata*, common dolphin *Delphinus delphis* and harbour seal *Phoca vitulina* – both the number and frequency of sightings was relatively small (Table 3.1). No bottlenose dolphin *Tursiops truncatus* were observed during any survey months across the DAS campaign.

22. There were also four cetaceans observed that could not be assigned to species level, and sightings classified as ‘seal species’ (due to the difficulty of identifying phocids to species level from aerial survey data). These unidentified species were observed in 16 of the 24 months surveyed.

Table 3.1: Monthly Raw Sightings Data (Number of Animals) (Uncorrected for Effort). To Improve Clarity and Aid Readability, Zero Counts are Indicated as Dashes

Survey	Harbour Porpoise	Minke Whale	Common Dolphin	White-beaked Dolphin	Grey Seal	Harbour Seal	Cetacean Species	Dolphin Species	Seal/Small Cetacean Species	Seal Species	Total
March 2021	3	-	-	-	-	-	-	-	-	1	**4**
April 2021	35	-	-	2	1	1	-	-	-	6	**45**
May 2021[1]	73	-	-	4	1	-	-	-	-	1	**79**
June 2021	71	-	-	-	4	-	-	-	1	1	**77**
July 2021	144	3	3	12	-	-	1	-	-	3	**166**
August 2021	5	-	-	-	-	-	-	-	-	1	**6**
September 2021	4	-	-	3	-	-	-	-	-	-	**7**
October 2021	2	-	-	-	-	-	-	-	-	-	**2**
November 2021	1	-	-	-	1	-	-	-	-	-	**2**
December 2021	4	-	-	-	-	-	-	1	-	2	**7**
January 2022	-	-	-	-	2	-	-	-	-	-	**2**
February 2022[2]	42	-	-	6	4	-	-	-	1	9	**62**
March 2022	5	-	-	-	-	-	-	-	-	2	**7**
April 2022	109	1	-	-	2	-	-	-	-	9	**121**
May 2022	11	-	-	-	2	1	-	-	-	3	**17**
June 2022	128	3	-	-	-	-	-	-	-	1	**132**
July 2022	125	5	-	-	-	-	-	-	1	4	**135**
August 2022	56	-	-	2	-	-	-	-	-	2	**60**
September 2022	2	-	-	1	-	-	-	-	-	-	**3**
October 2022	-	-	-	-	-	-	-	1	-	1	**2**
November 2022	8	-	-	-	-	-	1	-	-	-	**9**
December 2022	6	-	-	-	-	-	-	-	-	1	**7**
January 2023	-	-	-	-	-	-	-	-	-	-	**-**
February 2023	3	-	-	-	1	-	-	-	-	-	**4**
Total	**839**	**12**	**3**	**36**	**18**	**2**	**2**	**2**	**3**	**48**	**965**

[1]The May 2021 survey was replaced by a supplementary flight on 09 June 2021.

[2] The survey for February 2022 was conducted on 06 March 2022.

3.1.2. DENSITY ESTIMATES

Methodology

23. Relative density was calculated by dividing raw counts of each species by the area of transects covered by DASs (i.e. survey effort). Survey effort varied slightly between DASs (between 224 km^2 and 247 km^2) and therefore raw counts were always divided by the survey effort for the corresponding DAS (e.g. raw counts obtained during the March 2021 DAS were divided by the survey effort for the March 2021 DAS). Relative abundance of each marine mammal species was estimated by multiplying relative densities by the total area of the Array marine mammal study area (approximately 2,264 km^2). This process takes the density of marine mammals observed within the survey transects and applies it to the whole area of interest (i.e. the Array marine mammal study area) to estimate the number of individual marine mammals of each species that would have been observed if the whole extent of the Array marine mammal study area had been surveyed.

24. Diving species may be too deeply submerged for all present individuals to be detected during DASs, so to account for individuals that may not be visible, relative estimates of density and abundance were divided by species-specific correction factors obtained from the literature to estimate absolute density and abundance. Correction factors for these species were:

- harbour porpoise: 0.425 (Teilmann *et al.*, 2013);
- white-beaked dolphin: 0.180 (Rasmussen *et al.*, 2013); and
- grey seal: 0.156 (Thompson *et al.*, 1991, Orsted, 2018).

25. Mean densities of marine mammals were produced from the DAS count data, averaged at the monthly, seasonal and (where relevant) bio-season scale, and an overall mean was also estimated across the survey period. Coefficient of Variation (CV) was also calculated to present the variability in the raw data. Density estimates were calculated only for species that occurred at sufficient frequency to allow patterns of occurrence to be inferred: harbour porpoise, white-beaked dolphin and grey seal.

26. Due to reanalysis following an update to the raw data and additional quality checks, the site-specific densities from DAS data for harbour porpoise and white-beaked dolphin presented in this consultation note differ from densities presented in the Array marine mammal methodology note. Harbour porpoise densities differ only slightly with an absolute density of 0.660 animals per km^2 presented in this consultation note (design-based), compared to the absolute density of 0.650 animals per km^2 presented in the Array marine mammal methodology note (design-based). However, for white-beaked dolphin this difference is more substantial with an absolute density of 0.057 animals per km^2 presented in this consultation note (design-based for the summer bio-season), compared to the absolute density of 0.175 animals per km^2 presented in the Array marine mammal methodology note (design-based for the summer bio-season). As a result, white-beaked dolphin densities based on DAS data are currently not recommended to be taken forward to the EIA (see paragraph 53 for more detail).

27. Harbour porpoise was the only species which occurred in sufficient numbers during the DAS campaign for population modelling to be undertaken. This population modelling was undertaken using the R package MRSea (Scott-Hayward *et al.*, 2013) which allows predictions of spatial density to be estimated by modelling observed individuals against environmental variables (in this case: water depth, terrain ruggedness and distance from coast). MRSea requires a minimum of 30 observations in each grouping (e.g. survey month or season) for robust modelling to be achieved. There were a sufficient number of individuals for modelling when considered across the whole 24-month DAS campaign, and when aggregated by bio-season. Here, bio-seasons are defined for harbour porpoise according to the two divisions of the year described by Heinänen and Skov (2015): 'summer' (April to September) and 'winter' (October to March). Predictions from each MRSea model (including the 95% confidence interval) were projected to a grid of co-ordinates corresponding to the location of the Array marine mammal study area, and a mean relative density was calculated across the whole 24-month DAS campaign, and for each bio-season. Mean relative densities were then used as the basis for calculating relative abundance and absolute density and abundance.

Harbour porpoise

28. Mean densities of harbour porpoise produced from the DAS count data were averaged at the monthly, seasonal and bio-season scale and full results will be presented in the Array EIA technical report and associated appendices. Heinänen and Skov (2015) reported that pooling data according to temporal patterns of distribution for winter (October to March) and summer (April to September) is the most biologically relevant approach to studying harbour porpoise abundance/densities. As such, harbour porpoise abundance and density estimates presented in this section are focussed on winter and summer bio-seasons (Table 3.2).

Table 3.2: Summary of Relative and Absolute Harbour Porpoise Densities (Design-Based and Model-Based Estimates)

	Relative			Absolute		
Temporal Division	**Mean Abundance**	**Mean Density (Animals/km^2)**	**CV**	**Mean Abundance**	**Mean Density (Animals/km^2)**	**CV**
Design-based Estimate						
Winter Bio-Season	61	0.027	2.791	142	0.063	2.791
Summer Bio-Season	636	0.280	0.852	1,495	0.660	0.852
Model-based Estimate						
Winter Bio-Season	62	0.027	0.540	146	0.064	0.540
Summer Bio-Season	624	0.275	0.422	1,468	0.648	0.422

White-beaked dolphin

29. Mean densities of white-beaked dolphin produced from the DAS count data were averaged at the monthly and seasonal scale and full results will be presented in the Array EIA Technical Report and associated appendices. The analyses of survey data collected in the wider Firths of Forth and Tay over last 15 years demonstrated white-beaked dolphins have seasonal distribution with increased numbers of sightings during summer months (Grellier and Lacey, 2011, Sparling, 2012, SSE Renewables, 2022, Weir *et al.*, 2007). As such, the white-beaked dolphin abundance and density estimates presented in this section are focussed on meteorological seasons (Table 3.3).

30. White-beaked dolphin were not observed in sufficient numbers for robust modelling, and so their density using DAS data can only be estimated via design-based methods.

Table 3.3: Summary of Relative and Absolute White-Beaked Dolphin Densities (Design-Based Estimates)

Temporal Division	Relative			Absolute		
	Mean Abundance	Mean Density (Animals/km^2)	CV	Mean Abundance	Mean Density (Animals/km^2)	CV
Design-based Estimate						
Winter (December to February)	19	0.008	2.449	102	0.045	2.449
Spring (March to May)	10	0.004	1.673	56	0.024	1.673
Summer (June to August)	24	0.010	2.057	130	0.057	2.057
Autumn (September to November)	7	0.003	1.814	37	0.016	1.814

Grey seal

31. Mean densities of grey seal produced from the DAS count data were averaged at the monthly, seasonal and bio-season scale and full results will be presented in the Array EIA technical report and associated appendices. In the UK, grey seal distribution during the breeding season is very different to their distribution at other times of the year. Outside of the breeding season, about two-thirds of greys seals' time is spent at sea where they hunt and feed. In the autumn, between September to December grey seals congregate at traditional sites on land to breed. During the breeding season male grey seals also come ashore to mate. As such, grey seal abundance and density estimates presented in this section are focussed on breeding (September to December) and non-breeding (January to August) bio-seasons (Table 3.4). Grey seals were not observed in sufficient numbers for robust modelling, and so their density using DAS data can only be estimated via design-based methods.

Table 3.4: Summary of Relative and Absolute Grey Seal Densities (Design-Based)

Temporal Division	Relative			Absolute		
	Mean Abundance	Mean Density (Animals/km^2)	CV	Mean Abundance	Mean Density (Animals/km^2)	CV
Design-based Estimate						
Breeding Bio-Season	1	0.000	3.162	7	0.003	3.162
Non-breeding Bio-Season	12	0.005	1.155	77	0.034	1.155

3.2. TELEMETRY DATA

32. Telemetry data presented in this report for grey seal and harbour seal (sections 3.2.1 and 3.2.2, respectively) draws on the Sea Mammal Research Unit (SMRU) commissioned study (Stevens, 2023), which includes an analysis of existing satellite data to describe the movements of harbour and grey seal within or in the vicinity of the Array marine mammal study area. The site boundary is located within the East Scotland and Northeast England seal MUs and these are hereinafter referred to as "seal MUs of interest".

3.2.1. HARBOUR SEAL

33. The telemetry data confirmed that harbour seal usage within the Array marine mammal study area is very limited. A total of 46 harbour seals were tagged in the East Scotland seal MU between 2001 and 2018 and no seals were tagged in the Northeast England seal MU (Stevens, 2023). A further four harbour seals that were tagged elsewhere entered the seal MUs of interest (Figure 3.1). In total, there were 50 harbour seals tracked within the seal MUs of interest and of these, four had telemetry track data recorded within the Array marine mammal study area (Figure 3.2) (Stevens, 2023). All four of these were tagged within the Firth of Tay and Eden Estuary Special Area of Conservation (SAC), thus showing connectivity between the SAC and the Array marine mammal study area (Figure 3.2). The Firth of Tay and Eden Estuary SAC is located approximately 113.7 km to the west of the Array marine mammal study area (Figure 3.2). Given that the average foraging range of harbour seal is 50 km and that only 8% of all harbour seals tagged in the East Scotland seal MU showed connectivity with the Firth of Tay and Eden Estuary SAC, it is concluded that there is limited connectivity with the SAC.

34. Harbour seal tracks were recorded in the central and southern part of the Array marine mammal study area (Figure 3.2).

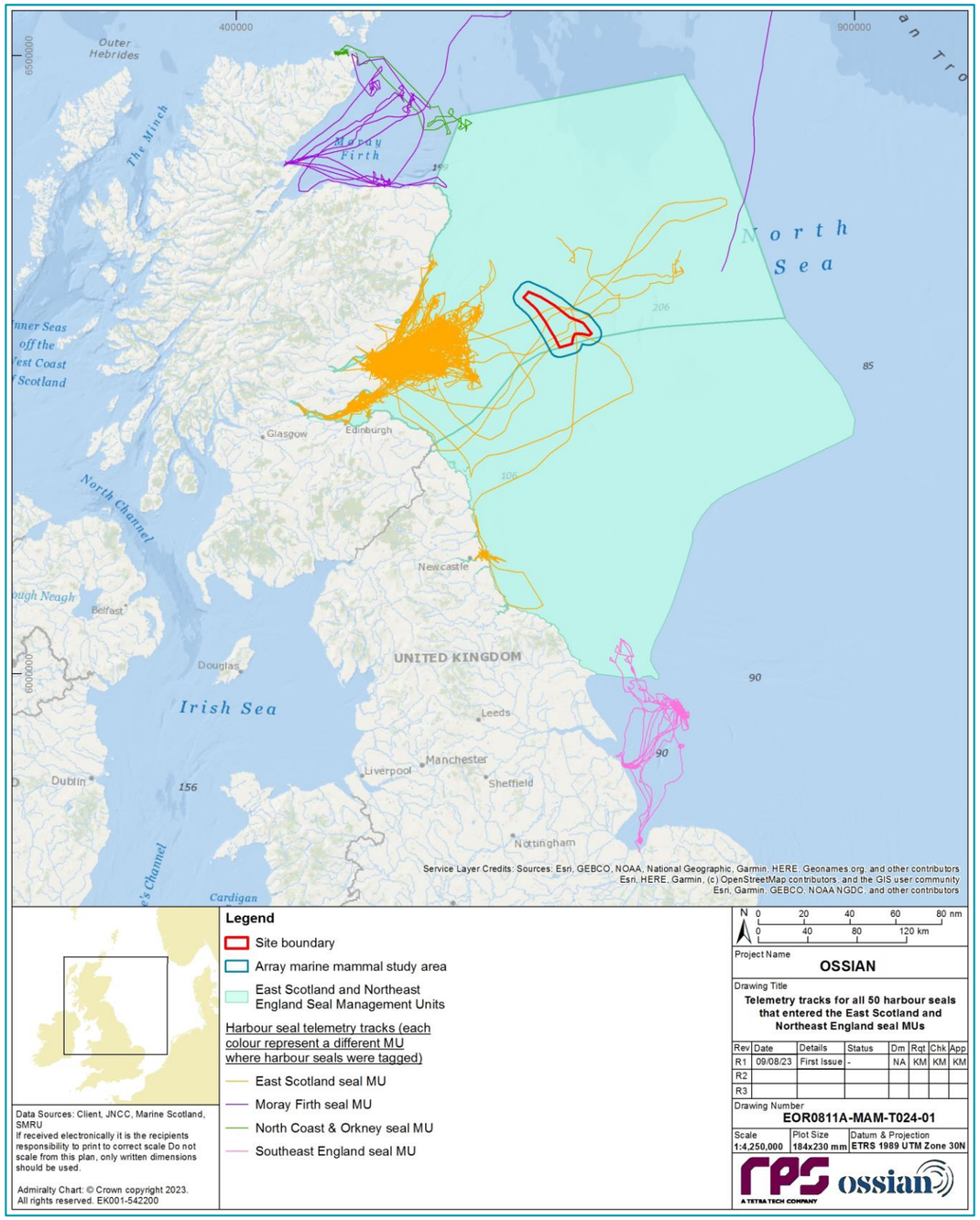

Figure 3.1: Telemetry Tracks of Harbour Seals that Entered the Seal MUs of Interest

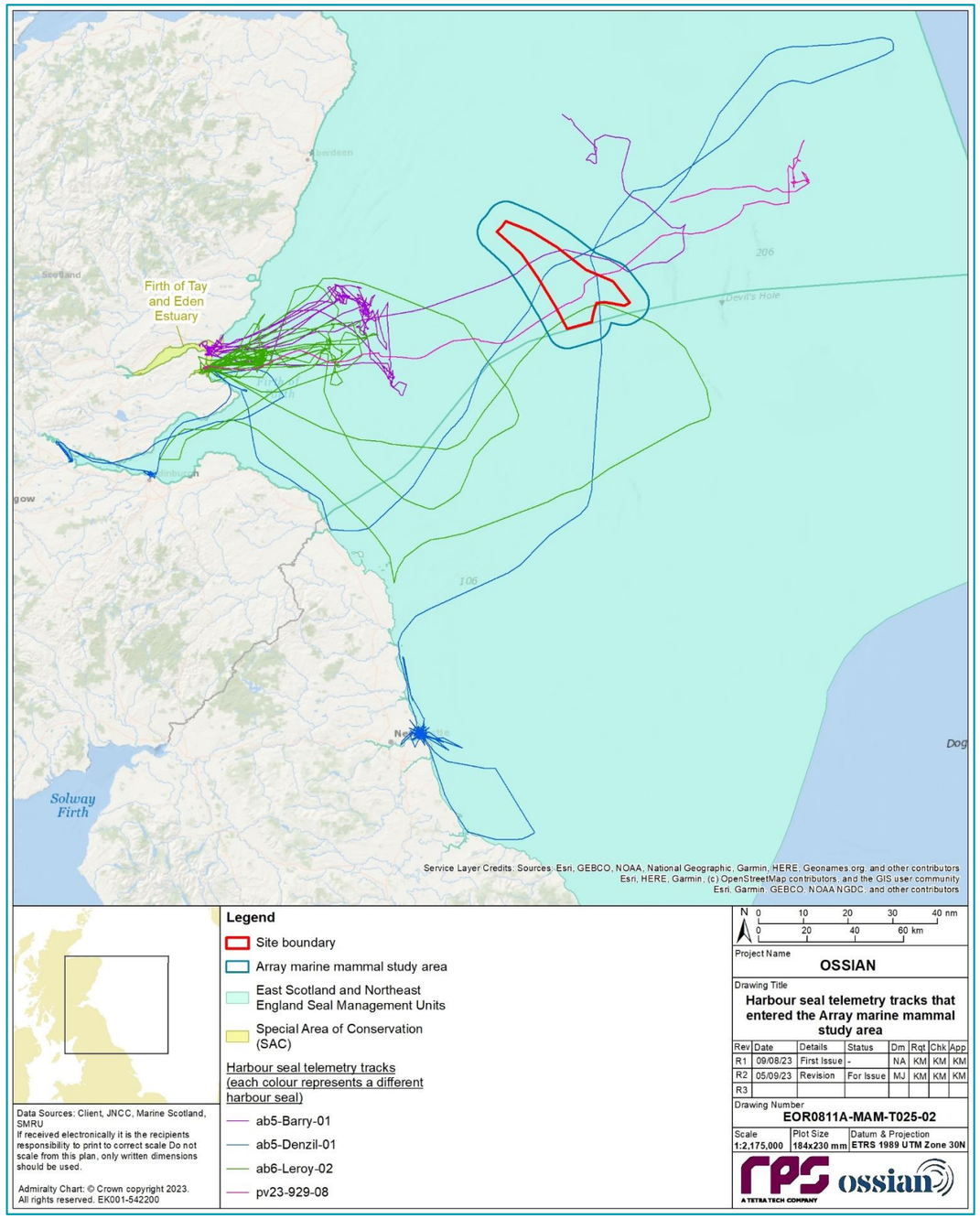

Figure 3.2: Telemetry Tracks of Harbour Seals with Connectivity to the Array Marine Mammal Study Area

3.2.2. GREY SEAL

35. A total of 105 grey seals of all age groups were tagged in the seal MUs of interest (Figure 3.3) between 1990 and 2014, 74 in the East Scotland seal MU and 31 in the Northeast England seal MU (Stevens, 2023), of which 68 were adults. A further 33 adult grey seals that were tagged elsewhere entered the seal MUs of interest.

36. In total, there were 101 adult grey seals tracked within the seal MUs of interest and of these, 18 were tracked within the Array marine mammal study area (Stevens, 2023). Fifteen of these individuals (five female and ten male) that showed use of the Array marine mammal study area also showed connectivity with at least one grey seal SAC (Figure 3.4). Connectivity with only the Isle of May SAC was observed in two adult grey seals, with only the Berwickshire and North Northumberland Coast SAC in nine adult grey seals, and with both SACs in four adult grey seals (Stevens, 2023). The Berwickshire and North Northumberland Coast SAC is located approximately 114.0 km south-west of the Array marine mammal study area (Figure 3.4). Given that only approximately 2% of all grey seals tagged in the seal MUs of interest showed connectivity with the Isle of May SAC (located approximately 130.9 km south-west to the Array marine mammal study area, Figure 3.4), it is concluded that there is limited connectivity with the SAC.

37. Connectivity was also noted between the Humber Estuary SAC (one male of unknown age), the Faray and Holm of Faray SAC (one adult male) and the Monach Islands SAC (one adult male). Given that these last three SACs are located at further distances from the Array marine mammal study area, there are lower levels of expected connectivity and therefore these SACs will not be considered further.

38. Adult grey seals tracks were recorded throughout the Array marine mammal study area, with a higher density of tracks in the south of the Array marine mammal study area (Figure 3.4).

39. Given that pup and juvenile movements may not be representative of the typical movement patterns of adult grey seals, their telemetry data is not presented in this consultation note but will be assessed in the Array EIA Technical Report and associated appendices.

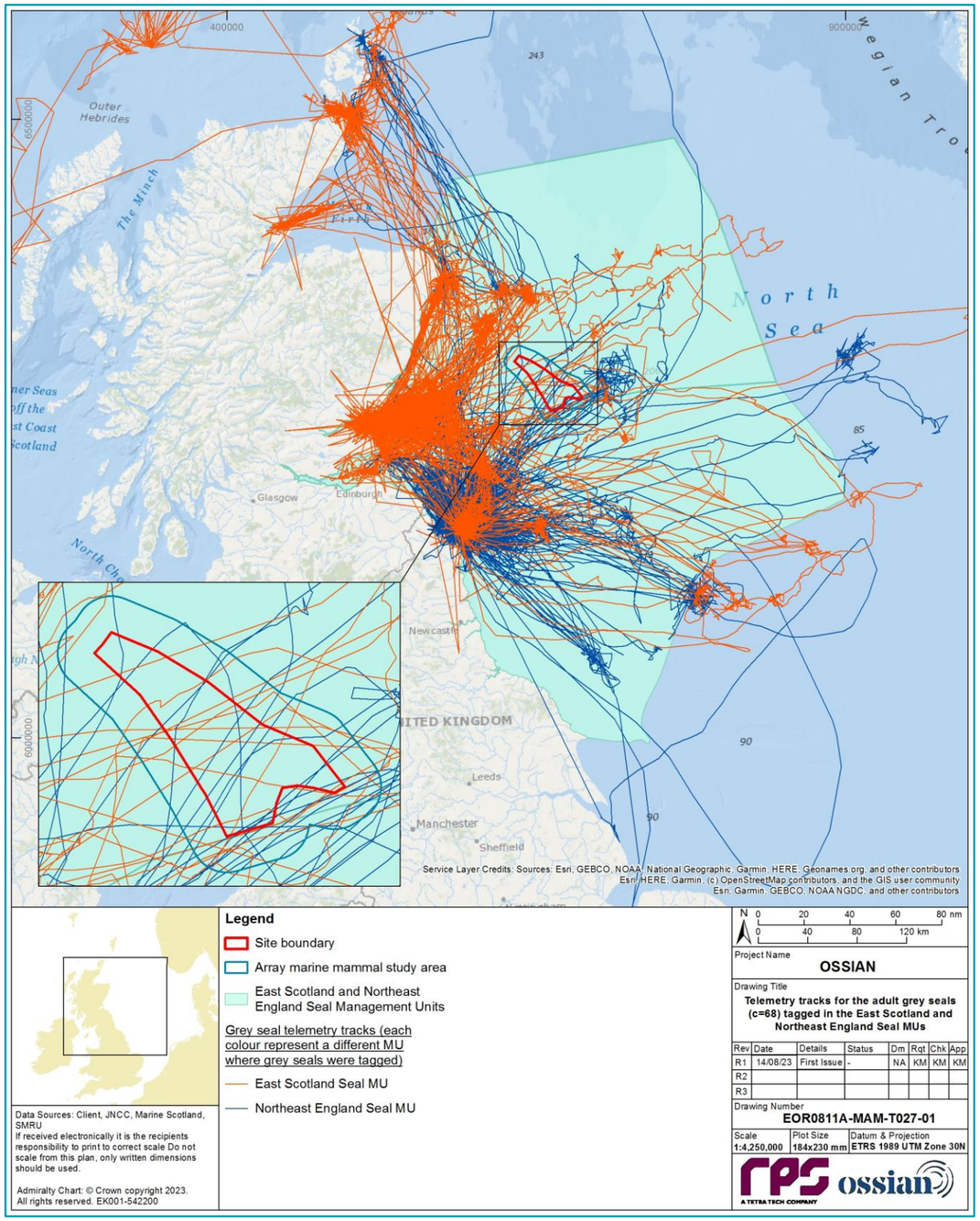

Figure 3.3: Telemetry Tracks of Adult Grey Seals Tagged in the Seal MUs of Interest

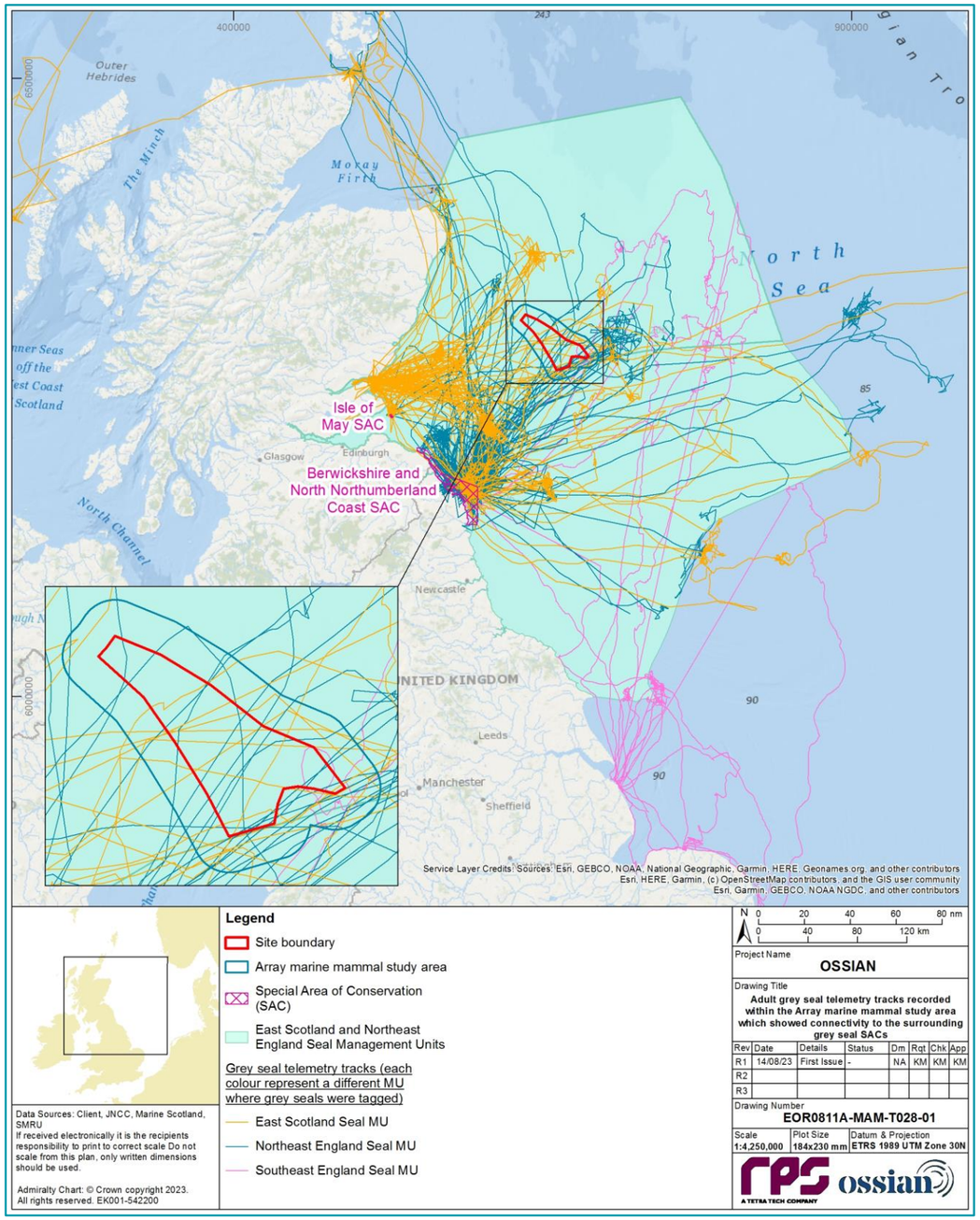

Figure 3.4: Telemetry Tracks of Adult Grey Seals with Connectivity to the Array Marine Mammal Study Area and SACs

3.3. SPECIES-SPECIFIC DENSITIES AND ABUNDANCE

40. In line with the Scoping Opinion (MD-LOT, 2023), densities based on both site-specific surveys and publicly available sources were considered. Following the feedback from NatureScot for the Array marine mammals methodology note received on 27 September 2023, a further justification for densities taken forward to the assessment in the EIA is provided in sections 3.3.1 to 3.3.6, based on best scientific evidence available from published literature. The aim of this analysis is to select a density value that strikes a balance between being precautionary but also reflecting spatial and temporal distribution within the area of interest (Array marine mammal study area). Humpback whale *Megaptera novaeangliae* is excluded from this analysis due to paucity of data for the regional marine mammal study area, the assessment in the Array EIA Report will be provided qualitatively for this species.

3.3.1. HARBOUR PORPOISE

41. Harbour porpoise are abundant throughout the North Sea with areas of higher density located in the southern North Sea. Comparison of key data sources for harbour porpoise densities is shown in Table 3.5.

42. Predicted estimates of mean density for the Array marine mammal study area from Waggitt *et al.* (2020) are comparable to the Small Cetaceans in European Atlantic Waters and the North Sea Survey (SCANS) III block R and SCANS IV block NS-D estimates (Table 3.5), but provide densities at a higher resolution (10 km x 10 km) and monthly frequency, rather than a single estimate over a wide area (as is the case with SCANS surveys which use large blocks). It should be noted that SCANS densities do not take into account variability in cetacean density associated with environmental covariates (such as depth, slope, distance from the coast). Additionally, both Gilles *et al.* (2023) and Hammond *et al.* (2021) highlight that the very short timeframe over which the SCANS surveys are conducted (summer) means that there is limited understanding of species distribution and abundance in other seasons.

43. Densities from Lacey *et al.* (2022) are derived from the same resolution as Waggitt *et al.* (2020) (10 km x 10 km) and are comparable to the design and model-based densities from DAS (Table 3.5). It should be noted that Lacey *et al.* (2022) used SCANS III data alongside the environmental covariates such as depth and slope in the density surface modelling. As reported by Heinänen and Skov (2015), the depth, amongst other parameters is an important predictor for harbour porpoise distribution. As such, studies that consider environmental factors are perhaps more robust when predicting harbour porpoise density.

44. Given the relatively high number of harbour porpoise sightings over 24 months of the DAS, it was possible to analyse the data and provide site-specific design-based as well as model-based density estimates (refer to section 3.1.2 for more detail). The most precautionary design-based absolute density estimates of harbour porpoise density from DAS presented in Table 3.5 are based on the “summer” bio-season.

45. When compared to studies analysing data from large scale surveys, such as SCANS, the results of the analysis of the site-specific DAS data are considered to be the most robust as these are based on the most recent data, collected regularly (monthly) over two years and over a specific area of interest (Array marine mammal study area). As such, it is considered that density estimates based on DAS data are the most appropriate to inform impact assessments and the absolute density of 0.660 animals per km^2 will be taken forward to the assessment.

Table 3.5: Comparison of Density Estimates for Harbour Porpoise. Densities in Bold Will Be Taken Forward to the Assessment in the EIA

Source		Density (Animals per km^2)
SCANS-III	Block R (mean) (Hammond *et al.*, 2021)	0.599
	(Lacey *et al.*, 2022)	0.783
SCANS-IV	Block NS-D (Gilles *et al.*, 2023)	0.5985

Source		Density (Animals per km^2)
Waggitt *et al.* (2020)		0.512
Site-specific DAS	**Design-based (absolute)**	**0.660**
	Model-based (absolute)	0.648

46. IAMMWG (2022) estimated harbour porpoise population abundance for the North Sea MU as 346,601 animals (CV = 0.09) and this abundance value will be taken forward to the assessment in the EIA. To provide context within the regional marine mammal study area, the SCANS IV block NS-D population of 38,577 harbour porpoises will be considered along abundance estimates for the North Sea MU (Gilles *et al.*, 2023).

3.3.2. BOTTLENOSE DOLPHIN

47. Overall, bottlenose dolphins are present across the northern North Sea, however, only the coastal population, distributed within the 2 m to 20 m depth contour and approximately 2 km from the shore, is well documented in literature. Comparison of key data sources for bottlenose dolphin densities is shown in Table 3.6.

48. There were no bottlenose dolphin sightings in block NS-D during the SCANS IV survey and therefore SCANS IV density values for bottlenose dolphins within this block are not available (Gilles *et al.*, 2023).

49. Predicted estimates of mean density for the Array marine mammal study area from Waggitt *et al.* (2020) are comparable to the Lacey *et al.* (2022) estimate and are provided at the same resolution (10 km x 10 km). Densities published by Hammond *et al.* (2021) are an order of magnitude higher, however these are based on one estimate for a large block that covers both inshore and offshore waters. The distribution of bottlenose dolphins within the Coastal East Scotland MU is restricted to coastal areas within 2 km to 5 km of the shore and therefore the density within these areas is expected to be higher than offshore (Palmer *et al.*, 2019, Thompson *et al.*, 2015, Quick *et al.*, 2014, Paxton *et al.*, 2016). As such, it is considered that densities presented in Hammond *et al.* (2021) may not be representative of the offshore waters, where the Array marine mammal study area is located. Lacey *et al.* (2022) maps reflect the coastal distribution of the Coastal East Scotland bottlenose dolphin population. Moreover, it should be noted that Lacey *et al.* (2022) used SCANS III data alongside the environmental covariates such as depth and slope in the density surface modelling. As reported by Thompson *et al.* (2015) and Palmer *et al.* (2019), depth is an important predictor for bottlenose dolphin distribution in eastern Scotland. Therefore, studies that consider the environmental conditions allowing to differentiate between different habitats (e.g. shallow vs deep) are most appropriate for predicting bottlenose dolphin density. Given that no bottlenose dolphins were recorded during DAS of the Array marine mammal study area, design or model-based density and abundance estimates for this species are not available. Therefore, density estimates reported by Lacey *et al.* (2022) most appropriately reflect densities of bottlenose dolphins in offshore waters where the site boundary is located, so a density of 0.00303 animals per km^2 will be taken forward to the assessment.

50. Arso Civil *et al.* (2021) estimated bottlenose dolphin abundance for the Coastal East Scotland MU as 224 animals and this abundance value will be taken forward to the assessment in the Array EIA Report.

Table 3.6: Comparison of Main Data Sources Densities for Bottlenose Dolphin. Densities in Bold Will Be Taken Forward to the Assessment in the EIA

Source		Density (Animals per km^2)
SCANS-III	Block R (mean) (Hammond *et al.*, 2021)	0.0298
	(Lacey *et al.*, 2022)	**0.0030**
Waggitt *et al.* (2020)		0.0021
Site-specific DAS	Design-based (absolute)	N/A
	Model-based (absolute)	N/A

3.3.3. WHITE-BEAKED DOLPHIN

51. White-beaked dolphins are abundant in the central and northern North Sea. Comparison of key data sources for white-beaked dolphin is shown in Table 3.7.

52. Predicted estimates of mean density for the Array marine mammal study area from Waggitt *et al.* (2020) are comparable to the Lacey *et al.* (2022) estimate and are provided at the same resolution (10 km x 10 km). Densities published by Hammond *et al.* (2021) are the highest, however these are based on one estimate for a large block and do not take into account variability in cetacean density associated with environmental covariates (such as depth, slope, distance from the coast). As reported by Weir *et al.* (2009) and Tetley and Dolman (2013), temperature and depth are important predictors for white-beaked dolphin distribution. Therefore, studies that account for environmental conditions allowing to differentiate between different habitats (e.g. shallow vs deep) are most appropriate for predicting white-beaked dolphin density, such as Lacey *et al.* (2022) and/or Waggitt *et al.* (2020).

53. Given the relatively high number of white-beaked dolphin sightings over 24 months of the DAS, it was possible to analyse the data and provide site-specific design-based density estimates (refer to section 3.1.2 for more detail). To provide the most precautionary figure, the design-based absolute density estimates from the DAS presented in Table 3.7 are based on summer meteorological season (June to August). The absolute density of 0.057 animals per km^2 calculated is approximately an order of magnitude lower when compared to density values from Waggitt *et al.* (2020) and Lacey *et al.* (2022). Although the reasons for such discrepancies are unknown, it can be hypothesised that the abundance of white-beaked dolphins on the east coast of Scotland may be lower compared to historic accounts due to rising sea surface temperature (van Weelden *et al.*, 2021). The white-beaked dolphin is endemic to the colder waters of the North Atlantic and prefer water temperatures ranging from 8°C to 13°C (MacLeod *et al.*, 2008). A number of studies have suggested that the abundance of white-beaked dolphins in the UK waters is declining as a result of increases in local water temperature (van Weelden *et al.*, 2021, MacLeod *et al.*, 2008, MacLeod *et al.*, 2005, MacLeod *et al.*, 2007, Lambert *et al.*, 2014). Findings from SCANS IV surveys conducted in 2022 also suggest a decline in the number of white-beaked dolphins on the east coast of Scotland with an estimated density of 0.0799 animals per km^2 for block NS-D (Gilles *et al.*, 2023) compared to the density of 0.245 animals per km^2 for block R during SCANS III surveys carried out in 2016 (Hammond *et al.*, 2021). Given that Waggitt *et al.* (2020) use the data collated between 1980 and 2018, the authors highlighted that the density estimates based on this study may not reflect recent changes in distribution over the study period. Therefore, to ensure that the density estimate is precautionary (with respect to corrected density estimates based on DAS of the Array marine mammal study area) and based on the most recent data and methodology that accounts for the habitat characteristic, it is considered that density estimates based on Lacey *et al.* (2022) are the most appropriate to use and a density of 0.120 animals per km^2 will be taken forward to the assessment.

54. IAMMWG (2022) estimated white-beaked dolphin abundance for the Celtic and Greater North Seas MU as 43,951 animals (CV = 0.22) and this abundance value will be taken forward to the assessment in the EIA. To provide context within the regional marine mammal study area, the SCANS IV block NS-D population of 5,149 white-beaked dolphins will be considered alongside abundance estimates for the Celtic and Greater North Seas MU (Gilles *et al.*, 2023).

Table 3.7: Comparison of Main Data Sources Densities for White-beaked Dolphin. Densities in Bold Will Be Taken Forward to the Assessment in the EIA

Source		Density (Animals per km^2)
SCANS-III	Block R (mean) (Hammond *et al.*, 2021)	0.243
	(Lacey *et al.*, 2022)	**0.120**
SCANS-IV	Block NS-D (Gilles *et al.*, 2023)	0.0799
Waggitt *et al.* (2020)		0.130
Site-specific DAS	Design-based (absolute)	0.057
	Model-based (absolute)	N/A

3.3.4. MINKE WHALE

55. Minke whale are widely distributed in the northern North Sea. Comparison of key data sources for minke whale is shown in Table 3.8.

56. The predicted estimate of mean density for the Array marine mammal study area from Waggitt *et al.* (2020) are lowest when compared to the Lacey *et al.* (2022) and Hammond *et al.* (2021) estimates. Densities published by Gilles *et al.* (2023) are the highest, followed by densities published by Hammond *et al.* (2021); however, both densities are based on one estimate for large survey blocks (block NS-D and block R) and do not take into account variability in cetacean density associated with environmental covariates (such as depth, slope, distance from the coast). Furthermore, both Gilles *et al.* (2023) and Hammond *et al.* (2021) highlight that the very short timeframe over which the SCANS surveys are conducted (summer) means that there is limited understanding of species distribution and abundance in other seasons. It should be noted that Lacey *et al.* (2022) used SCANS III data alongside the environmental covariates such as depth and slope in the density surface modelling, which are important predictors for minke whale distribution (Robinson *et al.* (2009); Robinson *et al.* (2021). As such, studies that consider the environmental conditions allowing to differentiate between different habitats (e.g. shallow vs deep) are most appropriate for predicting minke whale density. Minke whales were recorded in four months only during DAS and due to low numbers of sightings, design or model-based density and abundance estimates for this species are not available. Therefore, densities presented in Lacey *et al.* (2022) are the most appropriate to use for the specific area of interest (Array marine mammal study area) and so a density of 0.0284 animals per km^2 will be taken forward to the assessment.

57. IAMMWG (2022) estimated minke whale abundance for the Celtic and Greater North Seas MU as 20,118 animals (CV = 0.18) and this abundance value will be taken forward to the assessment in the EIA. To provide context within the regional marine mammal study area, the SCANS IV block NS-D population of 2,702 minke whales will be considered alongside abundance estimates for the Celtic and Greater North Seas MU (Gilles *et al.*, 2023).

Table 3.8: Comparison of Main Data Sources Densities for Minke Whale. Densities in Bold Will Be Taken Forward to the Assessment in the EIA

Source		Density (Animals per km^2)
SCANS-III	Block R (mean) (Hammond *et al.*, 2021)	0.0387
	(Lacey *et al.*, 2022)	**0.0284**
SCANS-IV	Block NS-D (Gilles *et al.*, 2023)	0.0419
Waggitt *et al.* (2020)		0.0116
Site-specific DAS	Design-based (absolute)	N/A
	Model-based (absolute)	N/A

3.3.5. HARBOUR SEAL

58. Harbour seals normally feed within 50 km around their haul out sites and therefore their presence in the offshore waters is limited (Table 3.9). Given that only a single harbour seal was recorded on two occasions during DAS, in April 2021 and May 2022, design or model-based density and abundance estimates for this species are not available. Carter *et al.* (2022) reports mean density of harbour seal across the marine mammal study as 0.00000064 animals per km^2.

59. Following feedback received in the Scoping Opinion from MD-LOT and NatureScot (MD-LOT, 2023), harbour seal was scoped in to the assessment and a thorough review of its distribution and ecology within the regional marine mammal study area was carried out during preparation of the Array EIA technical report. However, considering relatively short foraging ranges, low numbers of harbour seals detected during DAS, low at-sea harbour seal usage (Table 3.9) and very limited connectivity with the Array marine mammal study area based on the telemetry data (refer to section 3.2.2), the potential significant effects on harbour seal populations on the east coast of Scotland are highly unlikely. Therefore, the Applicant invites the SNCBs to reconsider their position on the advice provided with regard to including harbour seals in the assessment of potential impacts as a result of the construction, operation and maintenance and decommissioning of the Array. The Applicant proposes to include the detailed assessment of harbour seal ecology and distribution within the regional marine mammal study area in the Array EIA technical report and associated annexes (survey report and telemetry report), but suggest to exclude this species from further analysis in the marine mammal Array EIA Report Chapter.

Table 3.9: Comparison of Main Data Sources Densities for Harbour Seal

Source		Density (Animals per km^2)
Carter *et al.* (2022)		0.00000064
Site-specific DAS	Design-based (absolute)	N/A
	Model-based (absolute)	N/A

3.3.6. GREY SEAL

60. The east coast of Scotland and northern England provide important breeding and haul out habitats for grey seal (SCOS, 2023). Comparison of key data sources for grey seal is shown in Table 3.10.

61. Given relatively high number of grey seal sightings over 24 months of the DAS, it was possible to analyse the data and provide site-specific design-based density estimates (refer to section 3.1.2 for more detail). To provide the most precautionary figure, the design-based absolute density estimates from the DAS

presented in Table 3.10 are based on the non-breading bio-season (September to December). However, the predicted estimate of mean density for the Array marine mammal study area from Carter *et al.* (2022) of 0.180 animals per km^2 is higher than the absolute density of 0.034 animals per km^2 based on DAS data (Table 3.10).

62. Given uncertainties associated with identification of seals to species level based on DAS data, the density of 0.180 animals per km^2 based on Carter *et al.* (2022) will be taken forward to the assessment.

63. For pinnipeds (harbour and grey seal), it should be noted that the magnitude of effect with respect to behavioural disturbance during pilling will be calculated by overlaying the noise contours on the spatial seals at-sea density map provided by Carter *et al.* (2022) and summing the values for all cells where more than 50% of the cell lay within a contour. Therefore, densities presented in Table 3.10 will be taken forward for the assessment of other impacts, except for behavioural disturbance due to piling.

Table 3.10: Comparison of Main Data Sources Densities for Grey Seal. Densities in Bold Will Be Taken Forward to the Assessment in the EIA

Source		Density (animals per km^2)
Carter *et al.* (2022)		0.180
Site-specific DAS	Design-based (absolute)	0.034
	Model-based (absolute)	n/a

3.4. SUMMARY

64. Table 3.11 presents an overview of marine mammal densities and indicates the densities to be taken forward to the assessment in the Array EIA Report. As presented in paragraph 59, due to low numbers of harbour seals using the Array marine mammal study area, the potential for significant effects on harbour seal populations on the east coast of Scotland is very low. Therefore it is suggested that harbour seal will not be taken forward to the assessment in the Array EIA Report and as such, harbour seal densities are not included in Table 3.11.

Table 3.11: Summary of Marine Mammal Densities Taken Forward to the Assessment in the Array EIA Report

Species	Source	Density (Animals per km^2)
Harbour porpoise	DAS design-based (absolute)	0.660
Bottlenose dolphin	(Lacey *et al.*, 2022)	0.0030
White-beaked dolphin	(Lacey *et al.*, 2022)	0.120
Minke Whale	(Lacey *et al.*, 2022)	0.0284
Grey seal	(Carter *et al.*, 2022)	0.180

4. DESIGNATED SITES

65. Sites designated for the conservation of internationally important Annex II marine mammal species within the regional marine mammal study area include the Firth of Tay and Eden Estuary SAC designated for harbour seal, the Berwickshire and North Northumberland Coast SAC and Isle of May SAC both designated for grey seal, the Moray Firth SAC designated for bottlenose dolphin and the Southern North Sea SAC designated for harbour porpoise (Figure 4.1**Error! Reference source not found.**).

66. Following a comprehensive assessment of potential connectivity as well as feedback from NatureScot, Natural England and MD-LOT provided as part of the Scoping Opinion (MD-LOT, 2023), only sites presented in Figure 4.1 will be considered further in the EIA and HRA processes.

Table 4.1: Designated Sites Taken Forward to the Assessment in the EIA and HRA

Designated Site	Annex II Feature	Distance from the Array
Berwickshire and North Northumberland SAC	Grey seal	114 km
Southern North Sea SAC	Harbour porpoise	130.7 km
Moray Firth SAC	Bottlenose dolphin	176.5 km

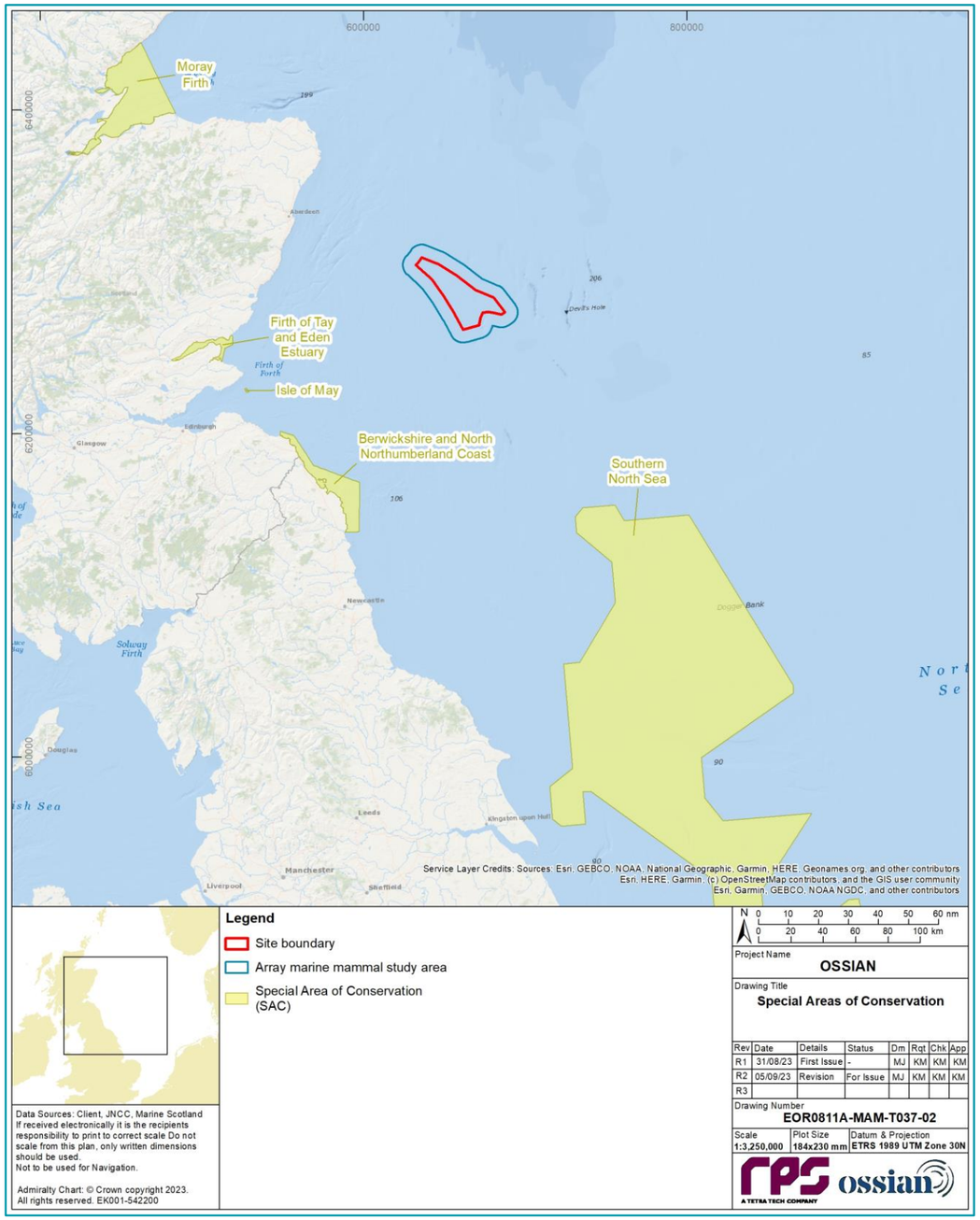

Figure 4.1: European Sites Designated for Protection of Annex II Marine Mammals Within the Regional Marine Mammal Study Area

5. IMPACTS TO BE SCOPED IN

5.1. OVERVIEW

67. Following feedback received from MD-LOT, NatureScot and Natural England as a part of the Scoping Opinion (MD-LOT, 2023), the list of impacts scoped in to the assessment in the Array EIA Report has been revised and is presented below:

- Construction:
  - injury and disturbance from underwater noise generated during piling;
  - injury and disturbance from underwater noise generated during Unexploded Ordnance (UXO) clearance;
  - injury and disturbance from underwater noise generated during vessel use and other noise producing activities;
  - disturbance from underwater noise generated during geophysical surveys;
  - injury due to collision with vessels; and
  - effects on marine mammals due to altered prey availability.
- Operation and maintenance:
  - injury and disturbance from underwater noise generated during vessel use and other noise producing activities;
  - disturbance from underwater noise generated during geophysical surveys;
  - injury due to collision with vessels;
  - effects on marine mammals due to Electromagnetic Fields (EMFs) from subsea electrical cabling in the water column;
  - injury and disturbance from underwater noise generated during the operation of floating wind turbines and anchor mooring lines;
  - effects on marine mammals due to entanglement associated with the Array; and
  - effects on marine mammals due to altered prey availability.
- Decommissioning:
  - injury and disturbance from underwater noise generated during vessel use and other noise producing activities;
  - injury due to collision with vessels; and
  - effects on marine mammals due to altered prey availability.

68. The approach to the assessment of injury and disturbance from underwater noise generated during piling, injury and disturbance from underwater noise generated during the operation of floating wind turbines and anchor mooring lines as well as effects on marine mammals due to entanglement associated with the Array was agreed as part of the Array marine mammal methodology note. Therefore, to avoid repetition, this consultation note will focus on the approach to remaining impacts associated with underwater noise, including:

- injury and disturbance from underwater noise generated during UXO clearance;
- injury and disturbance from underwater noise generated during vessel use and other noise producing activities; and
- disturbance from underwater noise generated during geophysical surveys.

5.2. APPROACH TO THE ASSESSMENT OF UNDERWATER NOISE

5.2.1. UXO CLEARANCE

69. The clearance of UXO prior to commencement of construction may result in high order detonation of the UXO. The high order detonation of UXO is considered a high energy, impulsive sound source with the potential to generate some of the highest peak sound pressures of all anthropogenic underwater noise sources (von Benda-Beckmann *et al.*, 2015). The potential impacts of this activity will depend on noise source characteristics, the receptor species, distance from the sound source and noise attenuation within the environment.

70. In line with the joint position statement (UK Government *et al*., 2022), the Applicant has committed to UXO clearance using low order detonation as the preferred technique. However, given that there is a small risk of unintended high order detonation, the assessment presented in the Array EIA Report will be based on high order detonation.

71. For marine mammals, Permanent Threshold Shift (PTS) injury thresholds presented in the Array EIA Report will be based on both Peak Sound Pressure Levels (SPL_{pk}) (i.e. unweighted) and marine mammal hearing-weighted Cumulative Sound Exposure Level (SEL_{cum}) as presented in Southall *et al*. (2019). A second threshold assessed, as a proxy for behavioural disturbance, will be the onset of Temporary Threshold Shift (TTS; unweighted SPL_{pk} and hearing weighted SEL_{cum}). The onset of TTS corresponds to a moving away or 'fleeing response' as this is the threshold at which animals are likely to move away from the ensonified area. The TTS onset is considered to represent the boundary between the most severe disturbance levels and the start of physical auditory impacts on animals and therefore reflects the threshold at which strong disturbance could occur. Whilst some ecological functions may be inhibited in the short term due to TTS, these are considered reversible on recovery of the animal's hearing (Finneran *et al.*, 2015) and therefore not considered likely to lead to any long-term effects on the individual.

72. The number of animals potentially affected by PTS and TTS will be calculated based on the maximum range of effect (high order detonation of a maximum UXO size likely to be encountered in the area) and species-specific densities as presented in section 3.3. The assessment of impacts in the Array EIA Report will also be informed by a total number of UXOs that will require clearance.

73. The designed in mitigation measures (primary and tertiary mitigation) proposed for the Array include use of Marine Mammal Observers (MMOs) and Passive Acoustic Monitoring (PAM), as well as Acoustic Deterrent Devices (ADDs) and soft start procedure in line with best practice guidelines (JNCC, 2010). Requirements to include secondary mitigation (e.g. noise abatement systems) for reducing the risk of injury from UXO clearance will be dependent on the significance of the effects, which are determined in part by injury ranges determining the magnitude of impact. As such, designed in mitigation measures as well as secondary mitigation will evolve as the EIA progresses and will be further discussed as part of the Array EIA Report Chapter as required.

5.2.2. VESSEL NOISE

74. Increased vessel movements during the construction, operations and maintenance, and decommissioning phases of the Array have the potential to result in injury or a range of behavioural effects to marine mammals such as avoidance behaviour, displacement as well as masking of vocalisations or changes in vocalisation rate. Vessel noise is considered a continuous, non-impulsive sound (Southall *et al.*, 2007).

75. The PTS injury thresholds presented in the Array EIA Report for vessels will be based on marine mammal hearing-weighted SEL_{cum} as presented in Southall *et al*. (2019). A conservative assumption has been made that all individual marine mammals will respond aversively to increases in vessel noise (i.e. that there is no intra or inter-specific variation or context-dependent differences). The distance over which effects may occur will, however, vary according to the species, the ambient noise levels, hearing ability, vertical space use and behavioural response differences. SELs will be estimated for each vessel type based on 24 hours continuous operation, although it is important to note that it is highly unlikely that any marine mammal would stay at a stationary location or within a fixed radius of a vessel for 24 hours. Therefore, the acoustic modelling will be undertaken based on an animal swimming away from the source (or the source moving away from an animal).

76. For continuous sound, the lowest sound pressure level at which a score of five or more on the Southall *et al.* (2007) behavioural response severity scale occurs for low frequency cetaceans is 90 dB to 100 dB re 1 µPa (rms). The National Marine Fisheries Service (NMFS (2005) guidance sets the marine mammal level B harassment threshold (analogous to disturbance) for continuous sound at 120 dB re 1 µPa (rms). The 120 dB re 1 µPa (rms) criterion is proposed as the basis for the onset of a strong behavioural reaction. It should be noted, however, that this is a highly precautionary threshold which does not consider background sound levels.

77. The number of animals potentially affected by PTS and behavioural disturbance will be calculated based on the maximum range of effect for each vessel type and species-specific densities as presented in section 3.3. The assessment of impacts in the EIA will also be informed by the total number of vessels on site at any one time alongside current baseline.

78. The potential risk of injury will be reduced by appropriate designed in mitigation measures, including vessel Code of Conduct. The Code of Conduct will include instructions for vessel behaviour and vessel operators, including advice to operators to not deliberately approach marine mammals and to avoid sudden changes in course or speed. Designed in mitigation measures will be further discussed as part of the Array EIA Report Chapter as required.

5.2.3. GEOPHYSICAL SURVEYS

79. Site investigation surveys will be carried out during the pre-construction as well as operation and maintenance phases of the Array to provide detailed information on seabed conditions and morphology, to identify the presence/absence of any potential obstructions or hazards, verify the seabed geology layers and carry out routine monitoring. Site investigation surveys are likely to involve geophysical surveys using several sonar-like source types (e.g. side-scan sonar (SSS)) and ultra-high resolution seismic (UHRS) as well as geotechnical surveys (e.g. cone penetration tests, vibrocores).

80. Depending on the source type, the PTS injury thresholds presented in the EIA will be based on either SPL_{pk} or SEL_{cum} thresholds as presented in Southall *et al.* (2019). For impulsive survey sound sources (e.g., ultra-high resolution seismic), the assessment will adopt the NMFS (2005) Level B harassment threshold of 160 dB re 1 µPa (rms). The NMFS (2005) guidance level B harassment threshold for continuous sound of 120 dB re 1 µPa (rms) will be used in the assessment for non-impulsive survey sound sources (e.g. side-scan sonar).

81. The number of animals potentially affected by PTS and behavioural disturbance will be calculated based on the maximum range of effect for each source type and species-specific densities as presented in section 3.3. The assessment of impacts in the EIA will also be informed by the duration of the site investigation survey campaign.

82. The designed in mitigation measures will also include use of MMOs and PAM, as well as soft start procedure in line with best practice guidelines (JNCC, 2017). Designed in mitigation measures will be further discussed as part of the Array EIA Report Chapter as required.

6. QUESTIONS TO STAKEHOLDERS

83. In order to appropriately inform the assessment of impacts on marine mammals in the Array EIA Report, the Applicant inquires feedback from the stakeholders on the following questions:

1. Are you content with the species-specific density estimates calculated based on DAS data and presented for harbour porpoise, white-beaked dolphin and grey seal in section 3.1?
2. Are you content with the species-specific density and abundance estimates to be taken forward to the assessment presented in section 3.3?
3. Are you content with suggested approach detailed in section 3.3.5 to include the detailed assessment of harbour seal ecology and distribution in the Technical Report but exclude this species from further analysis in the EIA Report Chapter due to low likelihood for significant effects (based on DAS (section 3.1.1) and telemetry (section 3.2.1) results)?
4. Are you content with the list of designated sites taken forward to the assessment in the EIA/HRA presented in section 4?
5. Are you content with the list of impacts to be scoped in to the assessment in the EIA presented in section 5.1?
6. Are you content with the approach to the assessment of impacts as a result of the underwater noise presented in section 5.2?

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